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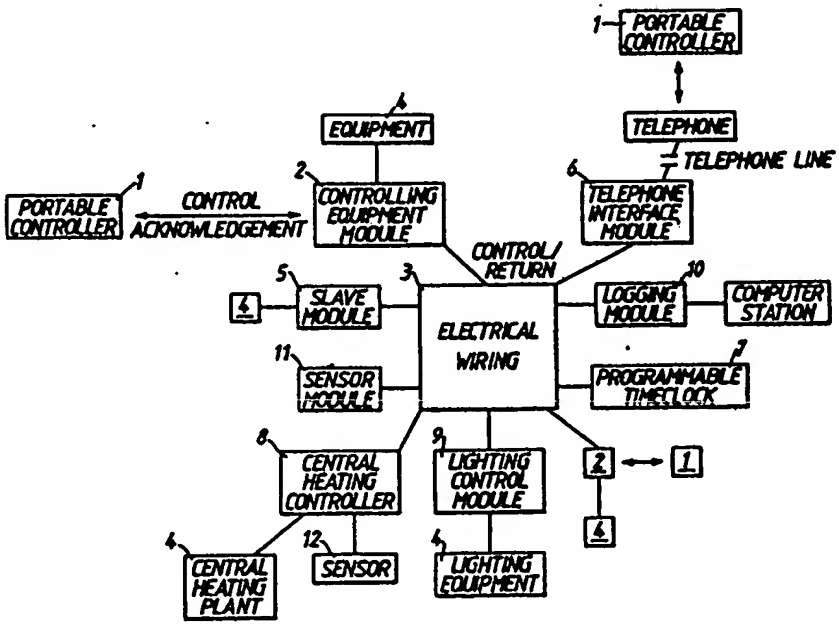

(57) Abstract

A system for the remote control of electricity supply to equipment comprises modules (2, 5, 6, 7, 8, 9, 10 and 11) interconnected via electrical wiring (3); some "equipment" modules (2, 5, 8 and 9) are connected to equipment (4) to be controlled. A cordless portable controller (1) is used which communicates with the system by transmitting radio, infra-red or ultrasonic signals to modules designated as controlling modules (2) which if necessary relay the signals to other modules via the wiring. Commands from the controller (1), contain addresses which the equipment modules compare with addresses stored therein; these addresses are preprogrammed into stores within the modules using the portable controller (1).

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A CONTROL SYSTEM

This invention concerns a system for the control of electricity supply to equipment by means of signals transmitted from a remote controller. In particular, the invention concerns a system of the type which utilise existing electrical power supply wiring lines as communications channels. This invention also concerns a module for use in such a systen.

Electrical power wiring lines are attractive for use as communications channels because they provide an already existing, and therefore cost free, transmission medium, with a largely unused bandwidth. Systems for the control of electricity supply to equipment that is already linked to an electrical power wiring line are conveniently implemented using the same wiring line. Systems for the control of electricty supply to equipment have been proposed in the past and much effort has been given to solving the problems of implementation. However, one area where the problems of existing systems have not been satisfactory overcome is that of the interface between the system and its users: Clearly, it is a major disadvantage for the user wishing to access the system if this is only possible, as in the prior art, at one location via a control console. One way of attempting to make such a system more convenient for the user is to install several control consoles at a variety of locations. However, this approach increases the expense of the system and its installation.

According to the invention there is provided a system for the control of electricity supply to equipment, to equipment, comprising a plurality of modules which, in use, are interconnected via electrical wiring; and wherein at least some of the modules have means arranged

in operation to receive command signals transmitted from a cordless portable controller aid to retransmitting such command signals over the electrical power wiring to other modules and at least some of the modules include store means for storing a respectfve module address or addresses means for controlling electricity supply to respective equipment connected thereto, in response to command signals, contains a destination address which received via the electrical power wiring.

Also according to the invention there is provided a module for use for use in a system for the control of electricity supply to equipment comprising store means for storing a respective module address or addresses, means for receiving command signals from the electrical power wiring and/or from a cordless portable controller and for controlling the electricity supply to equipment thereto in response to such command signals containing an address which matches the stored address or one of the stored addresses, and is operable in response to a program command message.

The system according to the invention may conveniently be accessed by a user from any desired locations in the vicinity of the system, and in some embodiments also from any telephone, in both cases by the use of the same pocket-size controller.

Embodiments of the system may be installed in any configuration with as many or as few modules as desired. Wired-in modules may be used, or plug-in modules may be used so that installation then involves merely plugging the modules into sockets connected to the electrical supply wiring and initialising them.

The invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a block diagram illustrating a system emboding the invention for the control of electricity supply to equipment.

Figure 2 is a flow diagram illustrating the operation of the equipment modules.

Referring to Figure 1 a system embodying the invention comprises equipment modules 2, 5, 8 and 9 which, in use, are interconnected with each other and other modules via the electrical power wiring 3, and have means for connection to respective equipment and appliances 4. There are two types of equipment modules: controlling modules, for example 2 (two of which are shown), and slave modules, for example in general 5, and a central heating controller 8, and a lighting control module 9. Controlling modules have means for communicating with a cordless portable controller 1, and means for relaying signals received from a cordless portable controller over the electrical wiring.

The equipment modules are basically controllable switches, electrically connecting (close-ciruit state) or disconnecting (open-circuits state) the respective equipment and appliances with an electricity supply. The state of the equipment modules (open - or close circuits) changes in accordance with instructions received in the form of coded control signals. The control signals may be modulated radio, electric signals super-imposed onto the electricity supply. Communication between the cordless controller 1 and the controlling modules 2 may be by means of modulated radio, infra-red (IR), or ultrasonic signals transmitted through the air.

The instructions originate from the user and are injected into the system from the cordless portable controller 1, which may typically have a keypad and an alpha-numeric custom display, and be designed to be pocket-size so the user may conveniently carry it.

The hand-held controller 1 may also transmit and receive acoustic tones for remote communication between the user and the system via the telephone network. In order to make use of this capability the system must in addition to equipment modules include a telephone - interface module 6, this module has means for connection to a telephone line and the electrical wiring and provides the link between them. It will be described in more detail later on.

A variety of other modules may also be included in embodiments of the system to enhance its capabilities, for example: a programmable-time clock module 7, this module is connected to the electrical wiring and has a clock and an instruction memory. It can be used to transmit instructions at pre-determined times; a logging module 10, this module is connected to the electrical wiring and logs all the signal activity on the wiring; and a sensor module 11 which can transmit a signal in response to a particular environmental condition. These modules will also be described in more detail later on.

Returning to the hand-held controller 1, this provides a link between the system, by using its receive/transmit capabilities, and the user, by using the keypad and display. When the user first aquires a system the hand-held controller must be initialised. This involves selection of a "house number" which must be input to the controller via its keypad and will then be stored in an on-board (preferably non-volatile) memory. The other modules may then be initialised in turn. To do this each module must first be connected to the electrical wiring, and then be switched to "programming mode". This may be done by inserting a key into the module, or by a switch, or the module may automatically be in 'programming mode' for a period of time after it is connected to the power

supply. An address selected by the user is then transmitted to the module using the hand-held controller. The module stores the address in a memory, and may then be switched out of "programming mode". The stored address can only be changed if the module is again switched to "programming mode".

Every module is allocated an address in this fashion. Every address has two parts: the "house number", and a module number. The "house number" once selected is the same for all modules initialised for a particular system, and ensures that each system is secure from signals of other systems using the same phase of the electricity supply. The module number must be selected by the user to be different for every module of any system and provides a unique address for every module.

Once initialised and incorporated into a system the modules remain in a quiescent state and may react to any instructions they may receive in control signals which contain the correct address. The control signals are transmitted in a format with a header which contains the address of the destination modules. In order to send an instruction the user must enter the module number on the keypad of the hand-held controller followed by an instruction code, the hand-held controller does not transmit the "house number" since the controlling modules insert this (see later).

In the case of equipment modules there are 3 basic types of valid instructions that may be received: a request to change to open-circuit state; a request to change to close-circuit state; and a request for status information.

Referring to figure 2, when a controlling module receives 20 a control signal transmitted from the controller, that is a radio, IR, or ultrasonic

transmission, the signal is decoded 21 by the controlling module and the header is checked 23 to see if the destination address coincides with the stored address of the control module in question. In the case where there is a match the module checks that the instruction is valid 24, if not an error message acknowledging signal is sent 25, if valid the module acts 26 on the instructions contained in the control signal, and transmits an acknowledging signal 27 back to the hand-held controller.

The acknowledging signal has an address header, but in this case, this contains the address of the controlling module in question, and the rest of the signal contains information regarding the new status of the controlling module. The hand-held controller, after transmitting a control signal awaits this response and accepts the first valid response received. If no acknowledging signal is received the hand-held controller eventually times out and displays an error message.

When a controlling module receives a control signal transmitted from the controller and the destination address does not coincide with the stored address, then the controlling module adds the 'house number' to the address header, and modulates the entire control signal onto an electrical signal and transmits it 28 onto the wiring. Before transmitting onto the wiring the controlling modules senses 29 the supply in the signal frequency band for a set length of time to see if it is busy. In the case where the supply is not busy the transmission follows immediately. If the supply is busy at any time during the set time the controlling module delays transmission 30. The length of the delay is related to the address of the module, so that should, two modules wish to transmit simultaneously collision is avoided. If the supply continues to be busy the module

eventually times out 31. This back-off procedure is adopted by all controlling modules before transmitting control signals.

When the supply is not busy and transmission of the control signal takes place the controlling module expects a return signal immediately after transmission, from the destination module. The first valid signal transmitted onto the wiring after transmission of a control signal is accepted 32 as the return signal and causes an acknowledging signal to be transmitted to the hand-held controller. The return signal and acknowledging signals are identical in this case, and have an address header which contains the address of the destination module in question, the rest of the signals contain information about the status of the destination module after the instruction has been obeyed. If no return signal is received 33 the control signal is retransmitted up to 6 times 34 if no return signal is received after the sixth attempt the module times out 35, and an error message is sent back to the portable controller.

When a modules receives 36 a control signal from the wiring it is decoded 37 and the header is checked to see if the destination address matches the stored address 38. If not the instruction contained in the control signal is ignored 39 and no further action is taken. If the destination address coincides with the module address then the instruction is checked for validity, if not valid an error message return signal is sent, and if valid the instruction is obeyed 40 and a return signal is sent 41. Since the return signal address header contains the address of the module which transmits it, the return signal is ignored by any other module that receives it from the wiring.

The longest turn-around time between the transmission of the last control signal from a controlling module and the receipt back of the return signal (when received) is shorter than the shortest set length of time that the module spends sensing the supply in the signal frequency band to check if it is busy before transmitting, so once a control signal is sent by a module no other module can transmit before the return signal should have been received back.

The hand-held controller will not time out after transmitting a control signal until after the longest possible time-out time of the controlling modules. Therefore no control signals will cause any changes in the system after the controller has timed out.

The slave modules, in general 5, receive only signals that have been modulated onto the electricity supply, not those directly transmitted from the hand-held controller. They do not retransmit control signals, but they do receive control signals from the wiring and transmit return signals onto the wiring as above. These modules are simpler and cheaper than controlling modules, and are useful in locations infrequently visited by the user or where several appliances are co-sited.

The telephone interface module 6, previously mentioned, provides a link between the electrical wiring and a telephone line, and permits the user access to the system from remote locations by the use of a telephone. In order to use this facility the user dials the line connected to the telephone interface modules. If the telephone is answered the telephone interface module may monitor the call, if the telephone is not answered then after a pre-determined ringing sequence the telephone interface module answers and announces itself to the user by using a voice synthesizer. At any time after the call

is answered the user may use the hand-held controller 1 to inject control signals in the form of acoustic tones into the telephone microphone. These control signals contain the 'house number' in the address header, and are transmitted as electrical signals down the telepone line and, provided the 'house number' is correct, are then relayed onto the electrical wiring by the telephone interface module in the same fashion as controlling modules.

The telephone interface module receives return signals from the wiring, and relays the information in the form of a synthesized voice acknowledgement to the user via the telephone line.

An answering machine may be connected to the telephone interface module in order to answer the telephone and record spoken messages. The telephone interface module may monitor such a call as above.

The programmable time clock modules 7, previously mentioned, have a clock, a keypad, a display, and an instruction memory. They may be programmed directly via the keypad or by using the hand-held controller and a set of time clock control signals either via a controlling module such as 2 and the wiring, or by direct transmission between the controller and the time clock module if the latter has this facility. Time clock control signals have a header with the time clock address, and an instruction portion which contains: a control signal, the address of the destination module for the control signal and information about the time that the control signal is to be transmitted to the destination module. The control signals are transmitted by the time clock modules using the same procedures as the controlling modules except that and no acknowledging signals are sent. However, a return signal store may optionally be provided which the user may

interrogate by the use of yet another set of control signals.

The central heating control modules 9, previously mentioned, are dedicated slave modules. They have the means necessary to control central heating plant that they are connected to, and the means to receive data from thermostats and other sensors 12 directly, and/or from sensor modules 11 via the electrical wiring in similar manner to the control signals. They control the plant in response to the data received from the sensors, or in response to control signals received from the wiring. These modules may have means to supply full status information concerning the heating plant.

Lighting control modules 9 are also dedicated slave modules. These have in addition to the open-and close-circuit state the means necessary to delivery any selected intermediate proportion of electrical power to the equipment. This is envisaged to be particularly useful to turn lights on or off or to "dim" them.

The logging modules 10 are connected to the electrical power wiring and have means for interfacing with a computer. These modules log the signals on the system and presents stored data concerning them to the computer upon request. This module also has means for permitting the system to be controlled by signals transmitted from the computer.

The sensor modules 11 are connected to the electrical wiring and transmit predetermined control signals to predetermined modules in the event of an environmental threshold (humidity, temperature etc) being breached.

It will be evident to the reader that a wide variety of other modules and different arrangements and combinations of the capabilities of the modules is possible for an embodiment of the system within the scope of the

invention. In particular, it is possible that the controlling modules need not be equipment modules. That is to say, they may be interconnected with other modules via electrical power wiring and have means for communicating with the cordless portable controller; but not means for connection to equipment and appliances, or connecting the equipment and appliances with the electricity supply.

Any module used in the system may include any of the capabilities of equipment modules if this is desired. Also the equipment modules may include means for the indepent control of several items of equipment. Alternatively, the modules may house built-in equipment and electricity power supplies, for example alarms, and batteries. All the modules may include means to enable the manual overriding of control signals. The modules may be wired into the electrical power wiring or may be detachably connected, for example they may plug in to wall mounted sockets. In any case the system may be expanded at any time by installing more modules, without affecting any existing modules.

The modules may respond to control signals transmitted to several addresses. This facility can be used, for instance, to programme several modules to respond to the same control signal sent to a particular address in addition to responding to control signals sent to their unique addresses. This 'broadcast' control signals can be sent to any particular subset of modules (eg all lights) to control them simultaneously rather than having to repeat the control signal to all the desired modules.

The communications protocols described in this embodiment of the invention are for example only. As described the use of signal addresses and sensing of the signal bandwidth of the electrical wiring before

transmission, renders the system secure from interference by unauthorised users and noise on the wiring, but any other protocols could be used if desired.

A block diagram of an equipment module is shown in Figure 3 and comprises a single-chip microprocessor 50 eg type 80C49 with on-board read-write memory 51, mask programmed read-only memory 52 and input output ports 53. It receives and transmits signal streams via a mains receiver and transmitter and an infra-red transmitter and receiver.

In the mains transmitter a 133kHz clock from a source 54 is gated on and off (55) under control of the processor to produce a pulse position modulated (PPM) signal stream. The 133kHz clock is band-pass filtered by filter 56 and amplified at 57. The output is therefore a stream of short bursts of 133kHz separated by different time periods representing '0', and '1' bits, supplied to output transistor 58.

The mains receiver comprises a buffer stage 59 to give the mains receiver a high input impedance, 133kHz filter 60, a further buffer 61 and a diode pump envelope detector 62. The input to the processor is a +5 volt level with 0 volt pulses representing the envelope of the 133kHz burst. The corresponding I/O port is periodically polled by the processor.

The mains receiver/transmitter switch is put into the receive mode, the normal state, by the processor holding the gate of a MOS field effect transistor 63 at a 0 level and turning it off. The received signal at the mains input terminals 65,66 is applied via a capacitor 67 which acts as a block to the 240volt, 50Hz mains but is transparent to the 133kHz signals, and stepped up by a transformer 64.

A 1 level on the gate of the transistor 63 turns it on and allows current to flow through the driver transistor 58. The collector current of the latter is 30mA to achieve a low output impedance for the transmitter. To further aid this, the transformer presents a step down turns ratio giving an impedance transformation resulting in a low output impedance.

The infra-red transmitter comprises a driver amplifier arrangement 68 via which a 0 pulse from the appropriate processor output port is caused to discharge a capacitor through infra-red light-emitting diodes 69. These diodes thus transmit a narrow infra-red pulse.

In the infra-red receiver negative going pulses are generated by an infra-red photo diode 70 in response to an infra-red transmission and amplified by a low noise, high gain amplifier 71. The pulse is applied to the clock input of the latch 72. The output of the latch results in an interrupt to the processor.

A non-volatile memory 73 is used to retain the user programmed house code and address, and the relay status when the unit is disconnected from the mains. It is written to and read from serially under control of the processor via lines 74.

A switch 75 (push-to-make) is operated by the user to toggle the state of the relay and to enter the programming mode.

The processor controls a relay 76 via a buffer stage 77.

Finally, a power supply 78 supplied power to other components of the equipment module.

The appliance module shown in Figure 3 corresponds to module 2 of Figure 1. For a slave module, of course, the infra-red signalling components can be omitted. Other modules referred to above, such as the telephone interface

and central heating controller are based on the same design but will require additional equipment eg a telephone modem and further I/O control ports respectively which can be interfaced via the microprocessor bus 74 (not used in the basic module).

The portable controller is shown in Figure 4. The microprocessor and infra-red transmitter are similar (except that the IR receiver is polled, rather than interrupt driven) to those employed in the equipment module and will not be described again. Corresponding parts are indicated by the same reference numerals with a prime ('). As the controller is assumed to be battery operated, and the processor can be placed, when the controller is switched off, in a 'stop' condition in which it ceases operation but memory is maintained with only minimal battery drain, a separate non-volatile memory is not provided.

The controlling operation of the equipment has been discussed above. However, some further description of the programming procedures is in order.

Assume that the house code has been entered into the portable controller (eg. by pressing a "program" key on the keypad and then the 6-digit number). In order to program an equipment module with its address, the following sequence is used:

The module to be programmed is connected to the mains and the controller is switched to infra-red signalling (ie not acoustic)

(a) using the controller previously programmed with the chosen house code, enter the required address on the keypad (one or two digits)

(b) press and hold the on/off button of the device to be programmed in order to place it in the programming mode

(c) point the controller at the IR receptor on the module to be programmed and press the "program" key. The controller then transmits a program command accompanied by the house code and equipment address. The module receives the code and address and stores it in its non-volatile memory 73 and transmits an acknowledgement to the controller. The controller display will show "..." until a reply is received and then display the address and "done" (flashing) if the operation has been successful.

(d) if the operation has failed for any reason or there is no reply the display shows "FAIL".

(e) after successfully programming a device the on/off key should be released and the device will retain its address and house code even when it is disconnected from the mains.

Alternatively the module can be programmed by signals sent along the mains wiring from another module. Obviously this is essential in the case of a slave module. The programming signals from the controller are received by the controlling module receiving them (which is not in 'program' mode) and relayed via the wiring, and will program any connected module which is in program mode.

The programming of the portable controller and applicance module to achieve these functions is illustrated in the flowcharts of Figures 5 and 6.

The controller (Figure 5) responds (100) to the 'program' key being pressed. If (101) a shift key is also pressed, it waits (102) for entry of a 6-digit house code and, when it is received, stores it (103).

If the shift key has not been depressed, the module address is then entered and digitally coded message is assembled (104) comprising a program command code, the stored house code, and the entered address. After transmission (105) of the message, the controller returns to receive and awaits (106,107) an acknowledgement. If this is received, or not received after a predetermined time (108), appropriate "DONE" or "FAIL" messages are displayed on the LCD display (109,110).

Upon exit from this section of the program, the controller deals with other functions (111) and returns to check the program key again.

In the appliance module interrupts (120) to the processor indicates that a message is being received by the infra-red receiver and the serially received message bits are assembled (121) in an internal register. The command portion of the message is checked (122) and acted upon: if the command is a program command and (123) the on-off switch is depressed (as indicated by the signals on the processor input port to which it is connected) then the remainder of the message is interpreted as house code and appliance module address and these are then stored (124) in the non-volatile memory 73; then an acknowledgement message is transmitted via the IR transmitter 68,69.

If the switch is not pressed, the program command is assumed to be intended for another module and it is forwarded serially (126) to the gate 55 of the mains transmitter.

Other functions are illustrated at 127. One of these other functions is polling the output from the detector 62 and assembling the bit serial message received. This eventuality is illustrated by entry point 128 to the flowchart and a program command is processed in the same way as before, so that a module (especially a slave

module) can be programmed via another module. In this case, of course, step 126 is unnecessary and is omitted. Also the "transmit acknowledgement" step (125a) is via the mains transmitter. These charges can be effected by setting a flag (step 129).

A mains borne acknowledgement is identified (130) in the module relaying the program command, and retransmitted (131) via its IR transmitter and therefore the acknowledgement is safely returned to the controller.

CLAIMS

1. A system for the control of electricity supply to equipment, comprising a plurality of modules which, in use, are interconnected via electrical wiring; and wherein at least some of the modules have means arranged in operation to receive command signals transmitted from a cordless portable controller and to retransmit such command signals over the electrical power wiring to other modules and at least some of the modules include store means for storing a respective module address or addresses and means for controlling electricity supply to respective equipment connected thereto, in response to command signals, containing a destination address which matches the stored address or one of the stored addresses, received via the electrical power wiring.

2. A system according to claim 1 in which each module is operable in response to a program command message from the controller to store a module address contained in that message in the said store means.

3. A system according to claim 1 or 2 in which at least one module having the said means for receiving signals from a cordless controller also includes the said means for controlling electricity and is arranged to effect such control in response to command signals receive directly from the controller, and in response to command signals retransmitted over the wiring by another controller.

4. A system according to any preceding claim wherein at least one of the modules has receiving means only for receiving command signals from the eletrical power wiring.

5. A system according to any preceding claim wherein at least one of the modules includes means for transmitting onto the wiring, signals containing information concerning the status of the supply of electricity to the respective

equipment, and at least one other module which includes means for receiving command signals transmitted from a cordless portable controller also include means for transmitting status signals to the cordless portable controller.

6. A system according to any preceding claim wherein at least one of the modules is interconnected to others of the modules by means of being removably plugged into sockets attached to the electrical power wiring.

7. A system according to any preceding claim wherein at least one module which includes means for controlling electricity supply to respective equipment is controllable to connect and disconnect the supply to that equipment and to deliver any selected intermediate proportion of the supply to the equipment.

8. A system according to any preceding claim wherein, at least one of the modules includes means for receiving command signals from a telephone line, and means for retransmitting such command signals over the electrical power wiring to other ones of the modules.

9. A system according to any preceding claim wherein at least one of the said modules includes: means for storing command signals; and means for transmitting the stored commands onto the wiring at predetermined times.

10. A system according to any preceding claim wherein at least one module which is arranged for retransmitting command signals onto the electrical wiring, is also arranged to examine the wiring for the presence of signals or noise and to delay transmission if the wiring is busy at any time during the examination.

11. A system according to any preceding claim wherein, at least one of the modules has means for sensing environmental conditions.

12. A module for use in a system for the control of electricity supply to equipment comprising store means for storing a respective module address or addresses, means for receiving command signals from the electrical power wiring and/or from a cordless portable controller and for controlling the electricity supply to equipment thereto in response to such command signals containing an address which matches the stored address or one of the stored addresses, and is operable in response to a program command message to store a module address contained in that message in the said store means.

13. A module according to claim 12 wherein the module is also arranged in operation to receive signals from the electrical power wiring; and to retransmit such signals to the cordless portable controller.

14. A system for the control of environmental conditions comprising a controller for, in use, controlling heating and/or ventilation, and/or humidity control equipment, and one or more remote sensors each responsive to environmental conditions and having a transmitter to transmit corresponding signals to the controller, in which the sensor(s) are arranged to transmit the said signals via the electrical power wiring.

15. A system according to claim 14 in which at least one sensor and its associated transmitter is housed in a unit which plugs into an electrical power socket.

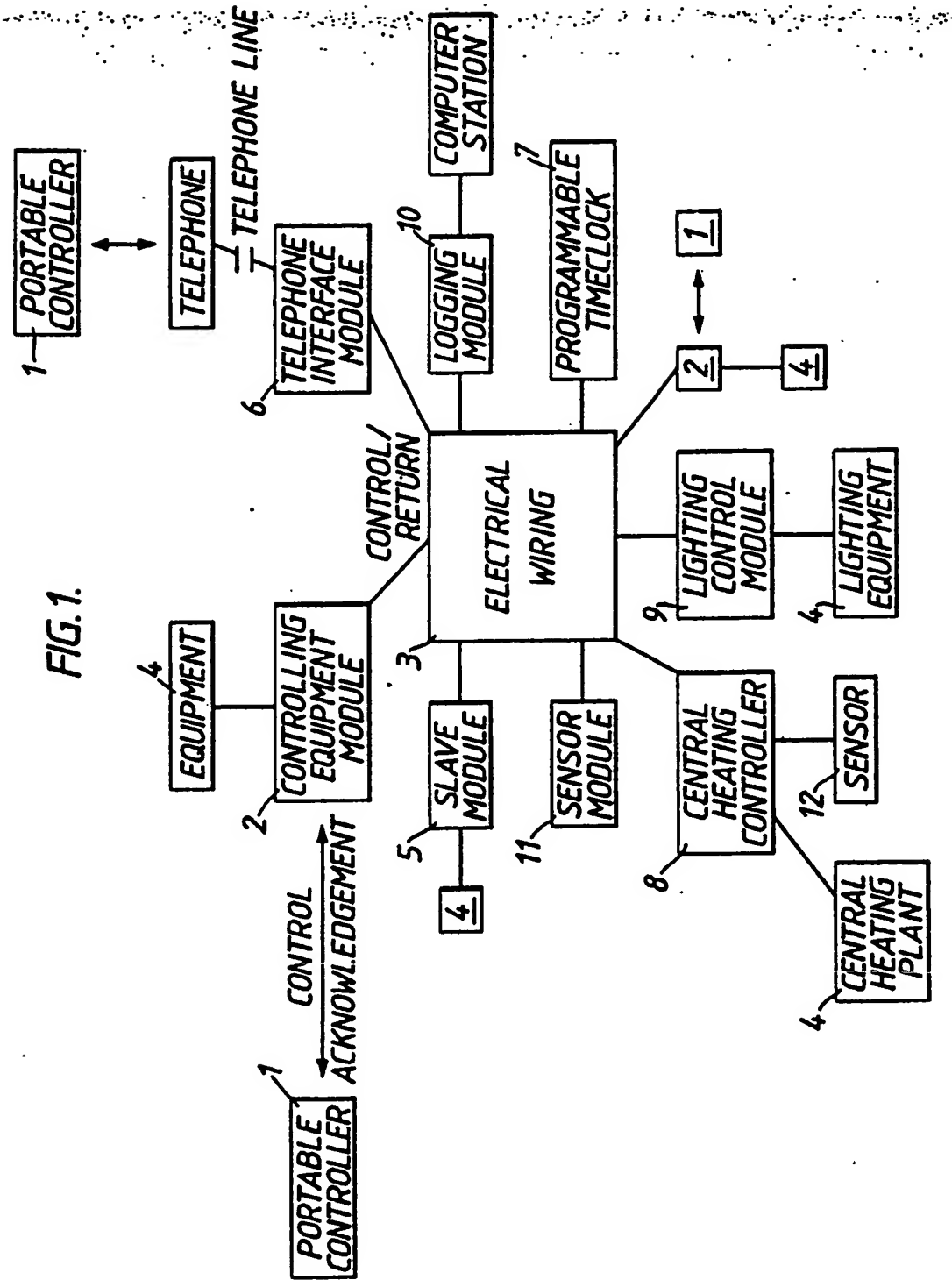


FIG. 1.

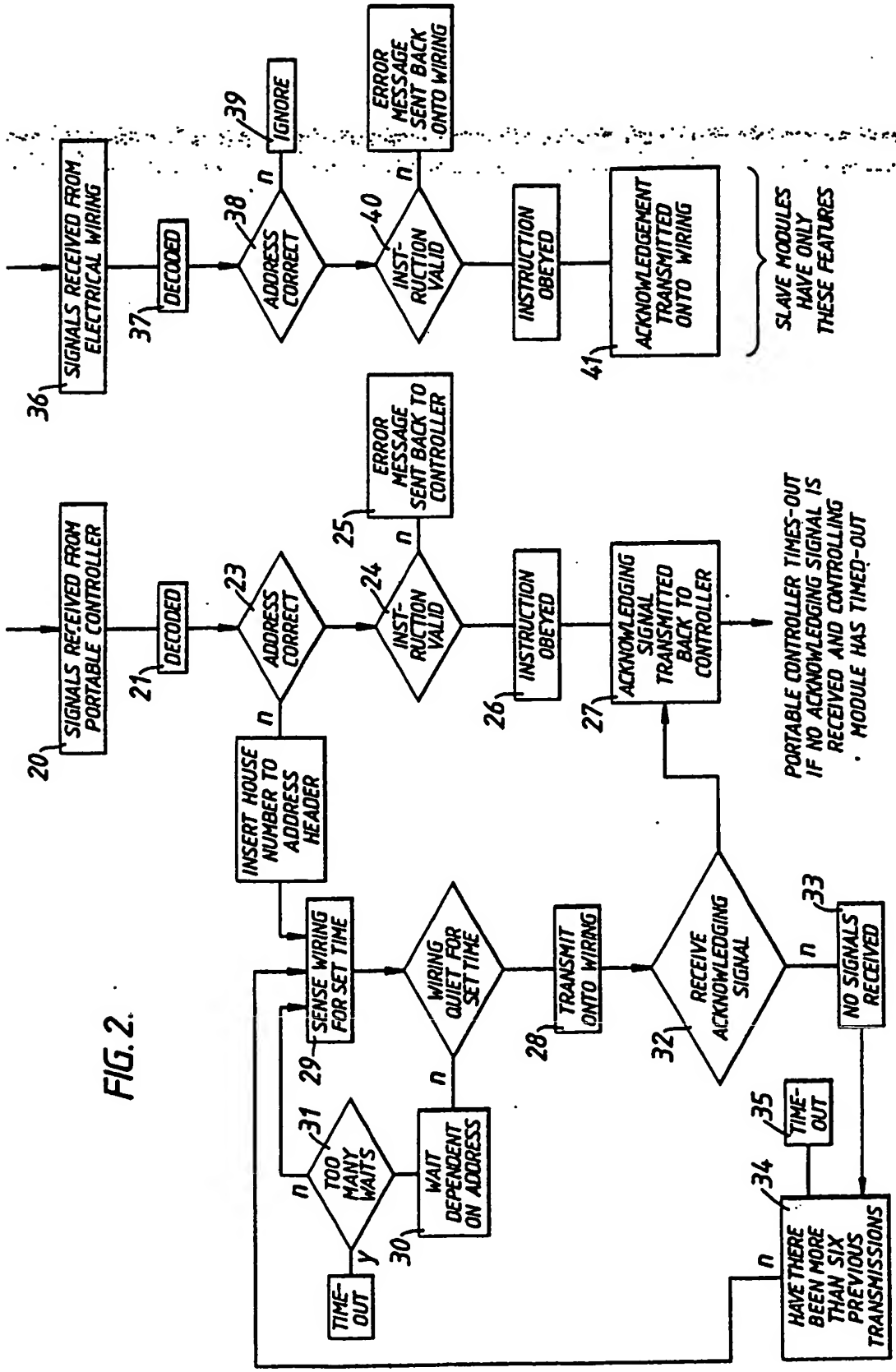
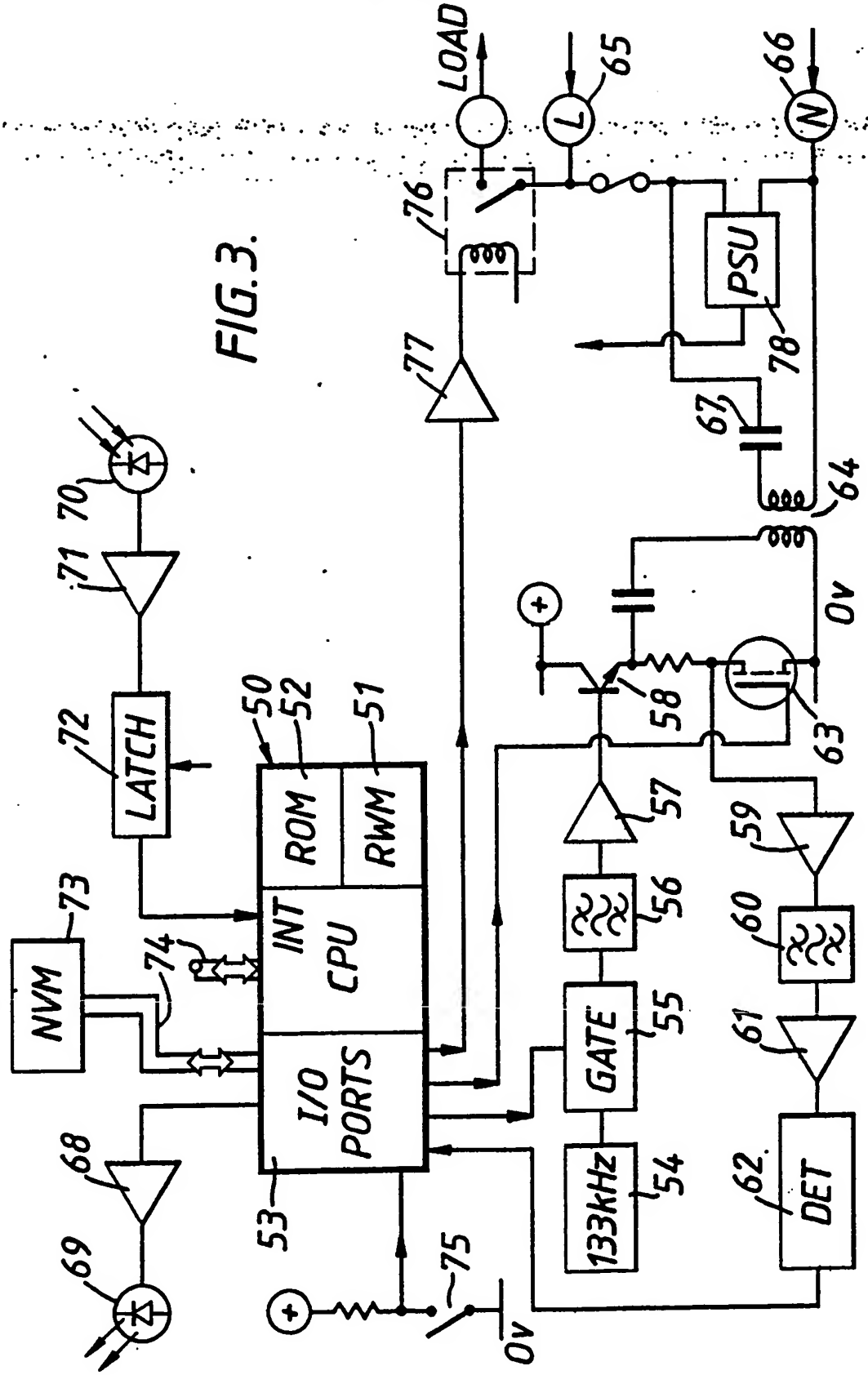


FIG. 2.

FIG.3.



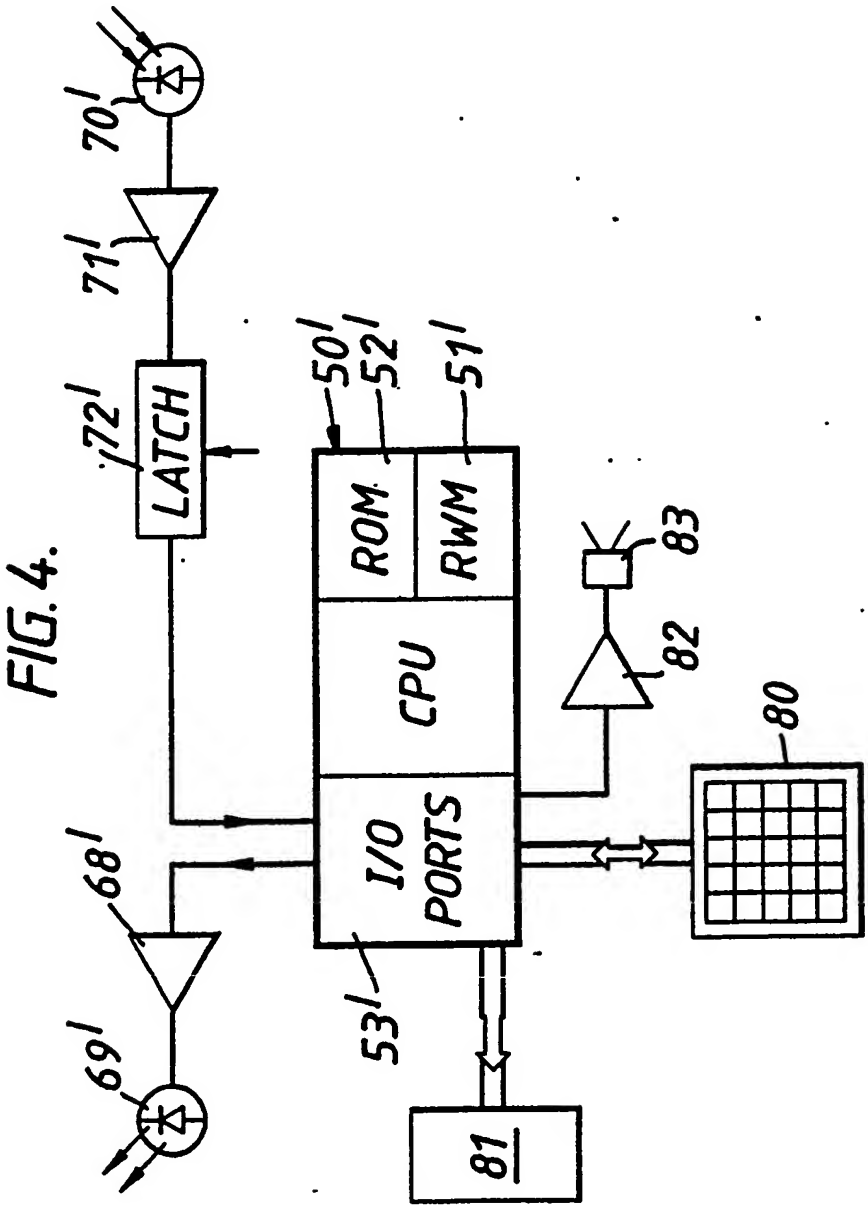
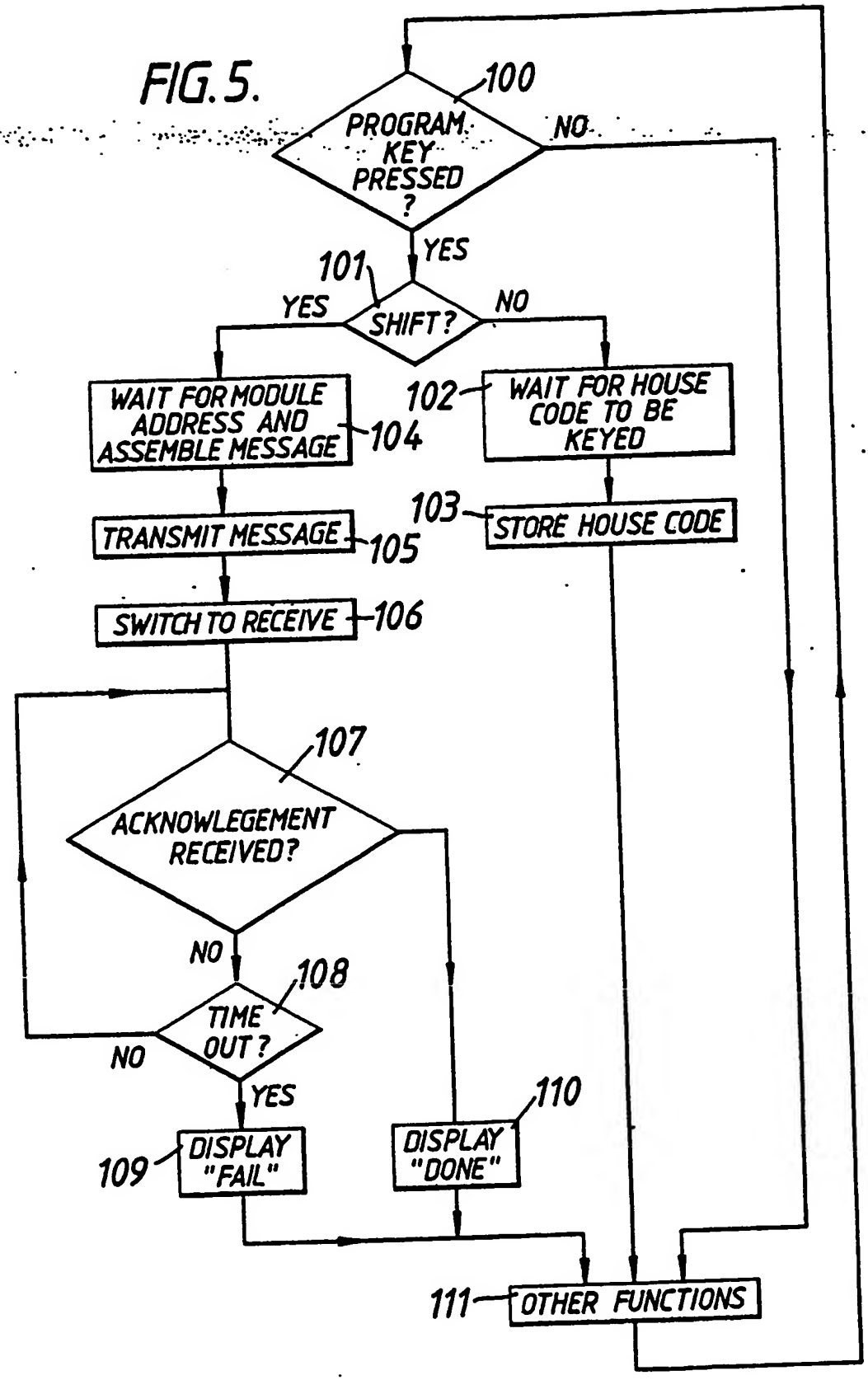


FIG. 4.

FIG. 5.



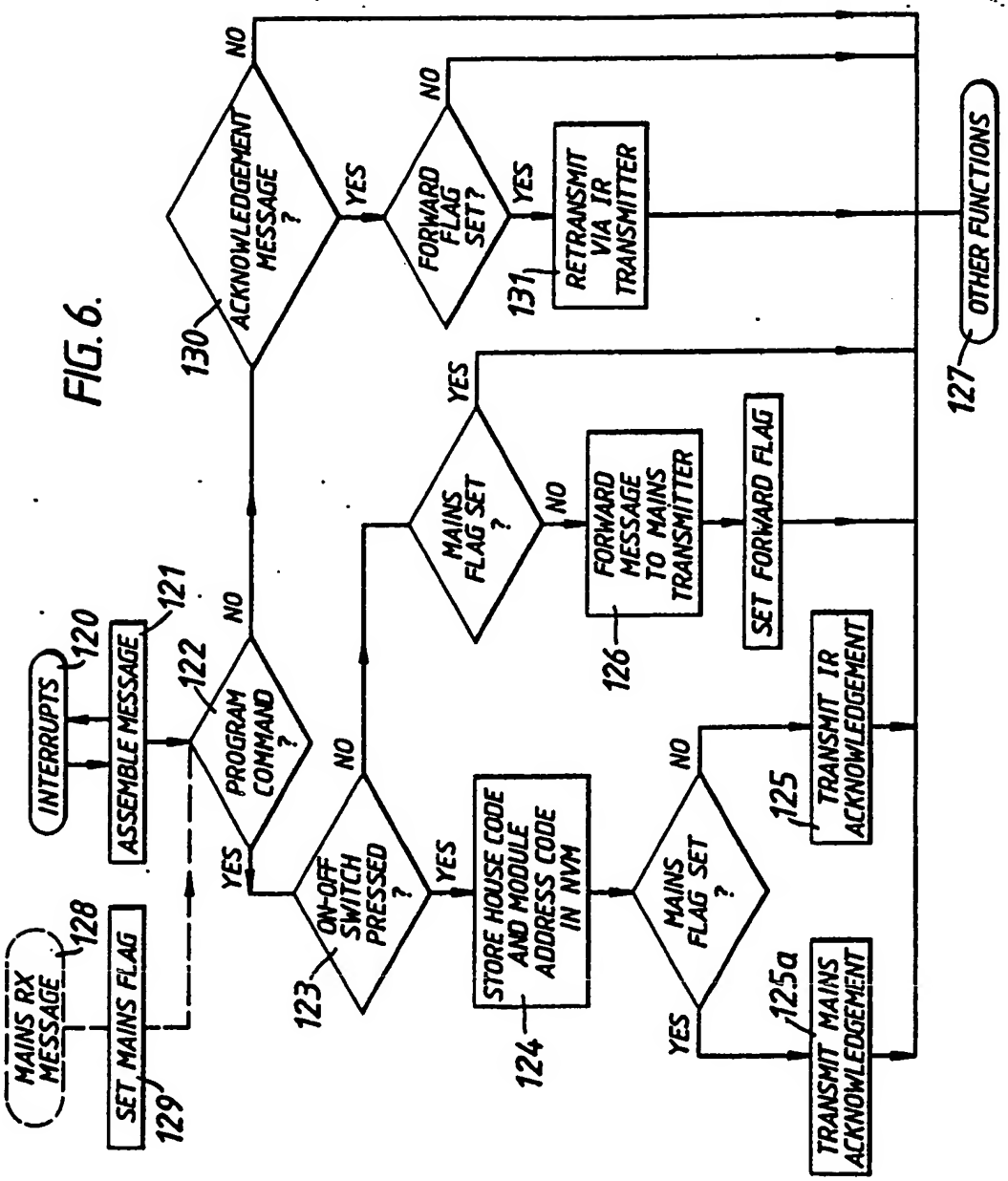


FIG. 6.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 86/00255

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: H 02 J 13/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	H 02 J

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	DE, A, 2800472 (PICO ELECTRONICS Ltd) 13 July 1978, see page 15, line 20 - page 17, line 16; figure 1	1,4,6,7
Y		2,5,8,9,11-13
X	DE, A, 2832942 (BROWN, BOVERI & CIE) 7 July 1980, see page 9, line 14 - page 11, line 21; page 12, lines 9-21; page 13, line 29 - page 15, line 10; page 18, line 12 - page 20, line 21; figures 1-8	1,14,15
X	DE, A, 3040081 (STANDARD ELEKTRIK LORENZ) 3 July 1982, see page 1, lines 1-13; page 4, line 10 - page 5, line 28; page 6, lines 6-27; figures 1,2	1,3
Y	US, A, 4396844 (E. MILLER) 2 August 1983, see column 8, lines 11-14; column 11, line 33 - column 13, line 25; column 13, lines 59-67; column 14, lines 11-62; column 19, line 46 - column 20, ./.	2,8,9,11,12

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
12th August 1986	28 AUG 1986
International Searching Authority: EUROPEAN PATENT OFFICE	Signature of Authorized Officer: M. VAN MOL

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
	line 39; column 38, lines 24-32; column 39, lines 52-60; figures 1,5	
Y	US, A, 4302750 (R. WADHWANI ET AL) 24 November 1981, see abstract; column 4, line 9 - column 5, line 45; column 10, lines 19-54; column 25, line 50 - column 25, line 25; figure 1	5,13
A	US, A, 4024528 (L. BOGGS ET AL) 17 May 1977, see abstract; column 1, line 66 - column 2, line 11; column 2, lines 26-46; figures 1,2	10
A	EP, A, 0069470 (PITTWAY CORPORATION) 12 January 1983	

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/GB 86/00255 (SA 13203)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 20/08/86

The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
DE-A- 2800472	13/07/78	US-A-	4200862	29/04/80
		GB-A-	1592971	15/07/81
DE-A- 2832942	07/02/80	None		
DE-A- 3040081	03/06/82	None		
US-A- 4396844	02/08/83	WO-A-	8101350	14/05/81
		DE-A-	3039666	14/05/81
		JP-A-	56082906	07/07/81
		EP-A,B	0038852	04/11/81
		US-A-	4367414	04/01/83
		AU-A-	6576280	22/05/81
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		US-A-	4484258	20/11/84
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		US-A-	4535332	13/08/85
		CA-A-	1198160	17/12/85
US-A- 4302750	24/11/81	None		
US-A- 4024528	17/05/77	None		
EP-A- 0069470	12/01/83	US-A-	4418333	29/11/83